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Lange, Martijn A. de; Knippenberg, Ad van

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To Err is Human:

How Regulatory Focus and Action Orientation Predict Performance following Errors

Martijn A. de Lange and Ad van Knippenberg

Radboud University Nijmegen

Martijn A. de Lange and Ad van Knippenberg, Behavioural Science Institute, Radboud University Nijmegen, Netherlands.

Correspondence concerning this article should be addressed to: Martijn A. de Lange, Behavioural Science Institute, Radboud University Nijmegen, P.O. Box 9104, 6500 HE Nijmegen, Netherlands. E-mail: M.delange@bsi.ru.nl.

Abstract

In the current study, we hypothesize that post-error performance is influenced by individual differences in action orientation and situationally induced regulatory focus. Two experiments employing a time pressured flanker-like task, measured participants' dispositional action orientation and manipulated regulatory focus. As expected, accuracy of the responses following errors was reduced for all participants except for action-oriented participants in a promotion focus. The latter participants are assumed to down-regulate error-related negative affect, thereby saving resources for subsequent performance. A promotion focus is assumed to facilitate the optimal use of these resources.

Keywords: Post-error performance, action orientation, regulatory focus, errors

"Errare Humanum Est"

- Seneca

Making mistakes can be very unpleasant, yet it happens to all of us. As the quote from Seneca in the motto above aptly states: To err is human. Consolation may be found in the suggestion that it is often not the mistake but the response to the mistake that matters. In this light, it seems unfortunate that mistakes tend to bring about more mistakes. Surprisingly, behavioral scientists rarely investigate the impact of erroneous responses on subsequent performance. Furthermore, little is known about why some people appear to suffer less from making mistakes than others. In the current paper we investigate how a dispositional manner of dealing with stressful situations combined with an individual's motivational orientation interact to overcome the detrimental influence that making a mistake may have on subsequent performance.

The origin of poor performance following mistakes may be found in a lack of cognitive resources available for post-error processing. Following an error, even though a response has already been given, the brain continues task processing (see also Kleiter & Schwarzenbacher, 1989). The resulting diminution of cognitive resources leads to suboptimal performance, such as slower or less accurate performance on subsequent tasks. Research has demonstrated that post-error responses are indeed characterized by slowing (Rabbitt, 1966, see also Fairweather, 1978) and inaccuracy (Rabbitt & Rodgers, 1977; see also Jentzsch & Dudschig, 2009). These effects have mainly been found in speeded response tasks, but there is some evidence of post-error slowing in the slower paced judgments of verbal analogies (Kleiter & Schwarzenbacher, 1989).

In what way the lack of resources impairs post-error performance (slowing, error-correcting responses, inaccuracy, etc.) depends on the specific task that is being performed. For example, in paradigms employing tasks with a small inter-trial delay but no time pressure, we may expect slowing following errors. People normally

strive to give correct answers and take more time to be able to give these answers following errors. Inaccuracy seems more likely in tasks with inherent time pressure. Given time pressure, post-error slowing may not be an option, in which case deteriorated post-error processing is likely to enhance incorrect responding.

Related to this reasoning is the notion that making an error is accompanied by aversive affect (e.g., Bush, Luu, & Posner, 2000; Hajcak & Foti, 2008; Luu, Collins, & Tucker, 2000; see also recent research on unintentional processing of motivational valence by Moors, De Houwer, Hermans, & Eelen, 2005). The negative affect activated by making an error may cause problems with the attentional disengagement from the erroneous trial (Van der Wulp, Semin, Galucci, & Finkenauer, 2009), thereby explaining the diminished resources in the following trial. This is not to say that activation of negative affect is dysfunctional. On the contrary, it may well be very functional as it provides a cue for detailed, bottom up processing (see e.g., Bless & Schwarz, 1999), which may be needed for a careful analysis of the committed error in certain tasks and situations. However, this mode of processing proves detrimental in situations requiring rapid changes in behavioral responses or speeded response tasks.

Given that an error activates negative affect, the manner in which an individual is able to efficiently regulate negative affect may predict the amount of attentional distraction from the performed task that he or she is subject to. Individual differences in dispositional cognitive and affective dynamics within the individual may thus be particularly important in dealing with errors under time pressure. A theory of self-regulation that focuses on these dynamics and more specifically on the regulation of affect is the theory of action orientation (Kuhl, 1981; 1994a). The theory of action orientation differentiates between a state-oriented and an action-oriented mode of behavioral control. We think that the consequences of making a mistake for performance on a task are dependent on the dispositional action or state orientation of the individual committing the mistake.

The action or state orientation of an individual is comprised of an over-learned set of routines used to cope with demanding situations and the aversive affect that accompanies them. Action-oriented individuals are characterized by down-regulation of the aversive affect evoked by stressful events and rapid mobilization of cognitive control resources. State-oriented individuals on the other hand, tend to ruminate on negative events. It is assumed that "state-oriented individuals will respond to stressful conditions with persistent negative affect, negative rumination and inhibited self-regulation" (Koole & Jostmann, 2004, pp. 975-976).[1] Research has indeed demonstrated that following failure in a training phase, performance decrements on a complex cognitive task were found for state-oriented, but not for action-oriented participants (Kuhl, 1981). Likewise, induction of stress leads to diminished cognitive control among state-oriented individuals, but not among their action-oriented counterparts (Jostmann & Koole, 2007). Furthermore, the down-regulation of negative affect responsible for these differences in performance was demonstrated to occur only for action-oriented individuals in demanding contexts (Koole & Jostmann, 2004).

Thus, in relatively stressful situations (e.g., fast paced tasks), action orientation theory predicts different reactions to committing an error. Due to difficulties in down-regulating the accompanying negative affect, state-oriented individuals are inclined to ruminate about their mistake, thereby hampering post-error performance (see also Holmes & Pizzagalli, 2007). Action-oriented individuals disengage from their mistake by the effective down-regulation of the associated negative affect and are able to perform post-error behavior relatively normally. However, this dispositional difference in dealing with errors is only part of the picture. Next to the stable ways of handling stressful situations, people are continuously influenced by temporary, more dynamic motivational factors.

Among motivational theories, the pleasure principle is thought to be one of the most basic forces guiding behavior. This principle entails that people approach

what they desire and avoid what appears threatening. This basic mechanism has lead to a substantial amount of research demonstrating that positivity is associated with approach movements and negativity with avoidance movements and vice versa (e.g., Cacioppo, Priester, & Berntson, 1993; Chen & Bargh, 1999; Solarz, 1960). These movements or bodily orientations may also be construed as fitting a higher order motivational system, described by regulatory focus theory (Higgins, 1997). This theory posits that (goal directed) behavior is guided by either a promotion or a prevention focus, which influences a host of cognitive processes. Regulatory foci have been shown to influence (among others) the interpretation of affective states (Shah & Higgins, 2001), the amount of attention dedicated to valenced stimuli (De Lange & Van Knippenberg, 2007), creativity (Friedman & Förster, 2001) and the effects of success and failure feedback on motivational strength (Förster, Grant, Chen Idson & Higgins, 2001).

Although people may differ as to which focus is preferred chronically, both foci are present in our behavioral repertoire and situational cues have been shown to activate the suitable regulatory focus in a wide variety of both judgmental and behavioral tasks (see e.g., Higgins & Spiegel, 2004, for a review). The focus that is activated is usually one fitting the specific situation, in terms of response strategy or processing style. In a promotion focus, people aim for gains, nurturance and there is a general eagerness to score results. In this focus, people tend to use approach means and “risky” response strategies or processing styles. In contrast, people in a prevention focus are concerned with (preventing) losses, security and are vigilant with regard to failure. In this motivational focus, the emphasis is on avoidance means and a more conservative response strategy. In general then, making an error should be more aversive for people in a prevention focus.

However, the extent to which action and state orientated individuals are able to effectively use their regulatory foci may differ, especially when regulation of affect that follows errors is involved. First, although state-oriented individuals are able to

activate both promotion and prevention foci, their affect regulation skills may cause difficulties in certain situations. People with a dispositional state orientation are chronically over concerned with the mistakes they make, even in conditions in which their focus is on gaining rewards (i.e., a promotion focus). The negative affect accompanying mistakes leads to rumination, thereby interfering with the eager response strategy activated by a promotion focus. Thus, state-oriented individuals can be motivated to look for hits, but they are dispositionally constrained to reflect on losses as soon as they occur. For state-oriented individuals then, performance following errors in fast paced response tasks will be hampered irrespective of which regulatory focus is active.

Action-oriented individuals are more flexible with regard to the influence of motivational orientations in these situations. The action orientation ensures the individual of the down-regulation of the negative affect associated with making errors and freeing up resources to help task performance. An active prevention focus with its loss-aversive, vigilant response strategy makes the action-oriented individual more cautious following an error, thereby slowing or hampering post-error performance, especially in time pressured tasks. However, a promotion focus complements the action orientation by providing an eager response strategy, putting to work the available resources. Thus, only the conjoint occurrence of both an action orientation and a promotion focus will lead to optimal performance following errors in situations where speeded responses are required.

The present research

The present research was designed to specifically investigate the behavioral effects of making a mistake in a time-pressured task. We hypothesize that post-error performance will be hampered (compared to post-correct performance), except for action-oriented individuals in a promotion focus. In two experiments, participants performed a cognitively demanding task wherein regulatory focus was manipulated using different procedures.

Since the present research is concerned with errors, we expect to find effects of action orientation as measured by the failure related subscale (AOF) of the Action Control Scale (Kuhl, 1994b). The AOF scale is thought to specifically measure the ability to down-regulate negative affect once it is aroused (see also Baumann, Kaschel & Kuhl, 2007; Kuhl, 1994a).

Experiment 1

Method

Participants and design. Sixty-one students (46 female) from the Radboud University of Nijmegen participated and received 1 or 2 euros (see below) as compensation. The design of the experiment was a 2 (result of previous trial: correct vs. incorrect) x 2 (regulatory focus: promotion vs. prevention) x 2 (AOF: action vs. state) mixed design. Result of the previous trial was a within-subjects factor whereas regulatory focus and action orientation were between-subjects factors. The dependent measure consisted of the proportion of correct responses on the current trial.

Experimental task. The task used in this experiment is based on the Eriksen Flanker task (Eriksen & Eriksen, 1974), which is commonly used to investigate error-related processes. In the classic flanker paradigm, participants are presented with a string of five symbols or letters (e.g., <<><< or SSHSS) and are asked to indicate what the middle symbol is (in these examples > and H). The symbols surrounding the middle symbol are irrelevant to the task, but do influence the speed and accuracy of responses. A match between the flankers and the middle, target symbol heightens accuracy and leads to faster responses than a mismatch. The task we designed for the current experiment required a similar, but more complex processing of the flanking stimuli.[2] Participants were presented with a grid of 3 x 3 letters (S and H) and were asked to indicate whether or not the middle, target letter corresponded with three of the four corner letters. Examples of the letter grids that were used in experiment 1 and 2 are presented in figure 1. All grids consisted of the letters S and

H (nine letters in total, four of one letter, five of the other), and there was either a match or a mismatch between the target and three corner letters. The grids were presented randomly with respect to their configuration, target letter and match. Matching and mismatching grids were presented equally often for both target letters. There was no influence of the target letter (S or H) on any of our analyses; this variable will therefore not be discussed any further.

Each letter grid was preceded by a fixation point for 400 ms, and was presented to the participants for 900 ms. The presentation ended after a response was given or after the 900 ms. expired. A response was given by pressing one of two marked keys on the keyboard (the “A” and “6” key on the numerical pad”) that corresponded with either a mismatch or match between the target letter and three corner letters. Upon completion of each trial, participants received feedback on their performance. One of three types of feedback was displayed on the screen, depending on the performance of the participant. Either the word “goed” (correct) in the color green, “fout” (false) in red or “te laat” (too late) in blue. This feedback remained on the screen for 1000 ms, followed by an inter-trial interval of 1500 ms.

Procedure. Upon arrival in the laboratory, participants were seated in individual cubicles containing a computer. On the computer screen, detailed instructions regarding the experimental task were presented and participants were shown examples of experimental trials. Following the instructions, participants were presented with 20 practice trials to familiarize themselves with the experimental task and to practice responding within the 900 ms. response window.

Upon completion of the practice trials, half of the participants received instructions that induced a promotion focus, the other half received instructions inducing a prevention focus. The promotion focus instructions were: “*You will receive one euro for this experiment, however: If you score amongst the 20 percent of all participants until now who make the smallest number of errors, you will win one extra euro! If you do not score amongst the 20 percent who make the smallest number*

errors, you will not win an extra euro." The prevention focus instructions were: "*You will receive two euros for this experiment, however: If you do not score amongst the 20 percent of all participants until now who make the smallest number of errors, you will lose one euro! If you do score amongst the 20 percent who make the smallest number of errors, you will not lose one euro.*" Similar instructions have previously been validated and used to induce regulatory focus in several studies (e.g., De Lange & Van Knippenberg, 2007; Higgins, Shah, & Friedman, 1997).

The experimental trials followed the induction of regulatory focus and consisted of two blocks of 60 trials, each preceded by four practice trials. In-between the two blocks, participants were shown their results so far (number of correct, false and too late responses) and presented with the promotion or prevention instructions as a reminder. Following the experimental trials, participants were asked to answer some demographic questions and to fill out a Dutch translation of the AOF subscale of the Action Control Scale (Kuhl, 1994b). Since action and state orientation are thought to be mutually exclusive, participants were coded as either predominantly action-oriented or state-oriented (cf. Kuhl, 1994b). The conceptual midpoint of the AOF scale (which corresponded with a median split on the scale) was used to code participants. Participants who gave six or more action-oriented responses were coded as action-oriented, participants who gave less than six action- oriented responses were coded as state-oriented.

At the end of the experiment, participants were shown percentages of the trials in which they reacted correct, false or too late and were informed whether their performance fell within the 20 percent limit or not. Dependent on their accuracy, participants were paid one or two euros. The 20 percent limit that was used was calculated on the basis of a pilot study.

Results and discussion

The proportions of correct responses following correct responses and following incorrect responses were calculated. Two different types of errors could be

made by participants: Giving the wrong response and not giving a response within the time window. However, there was no significant difference in the pattern of results for responding incorrectly or responding late on the previous trial. These two prior responses were therefore pooled into one measure of responding incorrectly. To test our hypothesis regarding the optimal combination of action orientation and regulatory focus for performing the experimental task, the proportions of correct responses were subjected to a repeated measures ANOVA with the results of the previous trial (within participants), regulatory focus and action orientation (both between participants) as factors.

Result of the previous trial had a significant main effect on proportion of correct responses, F (1, 57) = 16.06, p < .01, partial η^2 = .22. In general, as expected, responses following previous correct ones were more likely to be correct (M = .68, SD = .14) than following previous incorrect ones (M = .62, SD = .18). No significant main effects of either action orientation (F < 1, *ns.*) or regulatory focus (F (1, 57) = 1.87, p > .17) were found. The general interaction between action orientation and regulatory focus failed to reach significance (F (1, 57) = 3.14, p > .08) as did the interactions between previous result and action orientation and previous result and regulatory focus (both F's < 1, *ns.*).

The analysis did reveal the predicted interaction of the result of the previous trial with regulatory focus and action orientation, F (1, 57) = 6.51, p < .02, partial η^2 = .10. Looking at the more specific interactions within each type of result of the previous trial, the interaction between regulatory focus and action orientation was not significant for the responses made after a correct trial, F (1, 57) = 0.51, *ns*. Post-correct performance was thus not influenced by action orientation, regulatory focus or by a combination of both, which is in agreement with our predictions. However, in the case of post-error performance a significant interaction between regulatory focus and action orientation emerged, F (1, 59) = 5.64, p = .02, partial η^2 = .09. Simple effect

tests show that action-oriented participants in a promotion focus gave significantly more correct responses than action-oriented participants in a prevention focus or state-oriented participants with a promotion focus (see Table 1 for means). Additionally, accuracy did not differ for state-oriented individuals in a promotion or prevention focus, nor for participants in a prevention focus who were either action-or state-orientated. No main effects of either action orientation or regulatory focus were found (both *F*s < 1.5, *ns*.). These results support our hypothesis regarding post-error performance. Action-oriented participants in a promotion focus demonstrate superior performance following errors compared to all other participants.[3]

The participants' action orientation was measured at the end of the experiment, thereby risking contamination of this measure by the induced regulatory focus. Although we found no effect of the regulatory focus manipulation on the measured action orientation, F (1, 59) < 1, *ns*., this methodological flaw is remedied in the second experiment.

Experiment 2

Because we predict an interaction between three variables in a study employing a newly developed paradigm and a rather complex design, a replication of the results is in order to substantiate our findings. Thus, in the second experiment, we aim to replicate the superior post-error performance by action-oriented individuals with an active promotion focus. In this replication, we use a different method to induce regulatory focus to test the robustness of our findings.

Method

Participants and design. Sixty-two students (48 female) from the Radboud University of Nijmegen participated and received between 1.8 to 2.8 euros (see below) as compensation. The design of this experiment was a 2 (result of previous trial: correct vs. incorrect) x 2 (regulatory focus: promotion vs. prevention) x 2 (action orientation: action vs. state) mixed design. Result of the previous trial is a within-

subjects factor whereas regulatory focus and action orientation are between-subjects factors.

Procedure. Experiment 2 employed the same methodology as experiment 1, with three exceptions. The first change was the time of measuring the participants' action orientation. This was done by presenting the Action Control Scale (Kuhl, 1994b) at the start, rather than at the end of the experiment. The second change in methodology was the number of experimental trials. In the second experiment the participants completed three blocks of 60 trials, totaling 180 experimental trials.

The third change concerns the manner of manipulating regulatory focus. Participants received the same task instructions and practice phase as in experiment 1. However, the instructions we used to manipulate regulatory focus differed. A promotion focus was induced by explaining that money could be gained or not gained per trial, whereas a prevention focus was induced by similar instructions explaining that money could be lost or not lost per trial. All participants were told that they would receive 1 euro for the experiment, irrespective of their performance. However, participants in a promotion focus were told that they could gain another conditional 1.80 euros. For every correct response they would gain 0.01 euro, for every false or late response they would not gain money. This was reflected by the feedback these participants received after each trial. When a correct response was given, feedback consisted of "+ 0.01 €" written in a green color, whereas feedback consisted of "+ 0.00 €" written in red when no or a false response was given. A prevention focus was induced by explaining participants that they would receive a conditional 1.80 euros for the experiment on top of the unconditional euro, but that they would lose 0.01 euro for every false or late response, and not lose any money for every correct response. The feedback for prevention focused participants consisted of "- 0.00 €" in green when a correct response was given and "- 0.01 €" in red when no or a false response was given. Following each block of 60 trials, participants were informed of their performance so far and shown the amount of money gained/not lost. At the end

of the experiment, participants were informed of their performance and paid the amount of money they earned in the experiment, rounded up to the nearest 10 cent amount.

Results and discussion

The proportion of correct responses was calculated, both following correct responses on the previous trial and following incorrect responses, or missing responses on the previous trial. Again, no difference was found in the pattern of results for responding incorrectly or not responding on the previous trial. These two prior responses were therefore pooled into one measure of responding incorrectly.

Like in experiment 1, result of the previous trial had a significant main effect on proportion of correct responses, F (1, 58) = 15.94, p < .01, partial η^2 = .22. In general, responses following previous correct ones were more likely to be correct (M = .72, SD = .14) than following previous incorrect ones (M = .68, SD = .16). No significant main effects of either regulatory focus (F < 1, *ns.*) or action orientation (F (1, 58) = 3.58, p = .06) were found. The general interaction between action orientation and regulatory focus just failed to reach significance (F (1, 58) = 3.88, p = .06). The interactions between previous result and action orientation (F < 1, *ns.*) and previous result and regulatory focus (F (1, 58) = 2.87, p = .10) were not significant either.

In contrast to the first experiment, we did not find a significant interaction between the result of the previous trial with regulatory focus and action orientation, F (1, 58) = 1.16, p = .29. Failure to find this expected interaction was not due to the lack of the predicted pattern of results in post-error performance (see below). Rather, a similar, though non-significant pattern following correct trials was apparent in our results, F (1, 58) = 2.66, p = .11. This pattern explains the lack of the expected three-way interaction (see also Table 2).

However, the more specific and predicted interaction between action orientation and regulatory focus did reach significance when participants responded

incorrectly in the previous trial, F (1, 58) = 4.40, p = .04, partial η^2 = .07. Simple effect tests show a similar pattern of responding following errors as found in the previous experiment: Action-oriented participants in a promotion focus gave significantly more correct responses than either action-oriented participants in a prevention focus or state-oriented participants in a promotion focus (see Table 2 for means). No differences in accuracy were found for state-oriented participants in either a promotion or prevention focus nor for participants in a prevention focus who were either action-or state-oriented.

These results seem to be very much in line with the results of the first experiment. In both experiments, action-oriented participants with an active promotion focus were most accurate in their post-error performance. To check whether the pattern of results we found in experiment 2 are similar to the pattern found in experiment 1, we performed a meta analysis on the results.

Meta analysis

The data of the two experiments were pooled (N = 123) and analyzed in the same manner as reported above, with the addition of the between subjects factor study (1 vs. 2). Supporting our hypothesis, the interaction of the result on the previous trial with regulatory focus and action orientation (AOF) was highly significant (F (1, 115) = 7.22, p < .01, partial η^2 = .06). The specific study did not have an effect on this interaction (F (1,115) = 1.94, p = .17, partial η^2 = .02), indicating that the effects found in study 1 and 2 do not differ.

The three-way interaction effect on task performance was driven by the interaction between regulatory focus and action orientation following incorrect trials (F (1, 115) = 10.04, p < .01, partial η^2 = .08). This interaction was not significant after correct responses (F (1, 115) = 2.77, p = .10). Following incorrect trials, task performance by action-oriented participants with an active promotion focus was significantly better than the performance by action-oriented participants with an active

prevention focus (F (1, 121) = 11.50, p < .01) and better also than the performance of state-oriented participants in a promotion focus (F (1, 121) = 13.14, p < .01). Post-error performance did not differ for state-oriented participants in either a promotion or a prevention focus (F (1, 121) = 1.89, p = .17), nor for prevention focused participants who were either action-or state-oriented (F (1, 121) = 1.10, p = .29).

Additionally, simple effects analyses showed that action-oriented individuals in a promotion focus do not suffer a loss of accuracy following incorrect trials. Accuracy following incorrect trials (.74) was as high as accuracy following correct trials (.75; t (29) = .50, *ns*.). All other combinations of action orientation and regulatory focus did lead to significant losses in accuracy following incorrect trials (all t's > 3.36, all p's < .01). No differences of any kind were found for performance following correct answers.

General discussion

Seneca's full quote about erring reads "Errare humanum est. Perseverare diabolicum" or to err is human, to persist is diabolical. Seneca notwithstanding, the current study demonstrates that to persist in making mistakes is a very human property, at least in the domain of tasks requiring fast responses. The exception to this rule is formed by action-oriented individuals with a promotion focus. Individuals with this specific combination of dispositional affect regulation skills and active motivational orientation demonstrate optimal performance following errors when fast responses are required. To be more precise, in the current study the accuracy of responses on post-error trials diminishes, except for action-oriented individuals with a promotion focus who react as accurately after an error as after a correct response.

Our explanation with regard to the cause for the degraded performance in post-error functioning resides in the negative affect accompanying the error. Making a mistake activates negative affect, which makes attentional disengagement from the situation associated with the negative affect (i.e., the previous trial) difficult. This

impedes good performance in subsequent trials by occupying resources needed for task processing.

It follows that there are two prerequisites to perform well despite making mistakes in time-pressured tasks. First, one needs effective affect regulatory skills to down-regulate the activated negative affect, thereby freeing resources for subsequent task performance. Secondly, to effectively use these resources, a motivation to achieve hits (and thereby being relatively unconcerned with mistakes) is needed. As the current study suggests, the unique combination providing these prerequisites is an action orientation combined with a promotion focus. Note that these results are restricted to the domain of time-pressured tasks, or tasks requiring quick changes in behavior. The negative affect activated by making mistakes may be very functional in other situations where one is able to analyze the cause of the mistake and possibly correct it (see also Koole, Kuhl, Jostmann, & Vohs, 2005).

Behind this explanation lies our assumption that action- and state-oriented individuals differ in their flexibility regarding regulatory foci. Both state- and action-oriented individuals may be able to activate either a promotion or a prevention focus, but it depends on specific situations how effective this motivational orientation can be. For state-oriented individuals, a promotion focus may provide the eagerness to score hits, but this will be functional only in relatively relaxed situations. In stressful situations, involving the activation of negative affect, a promotion focus may be active, but is likely to be ineffective. The activated negative affect is not down-regulated effectively by state-oriented individuals, leading to distraction and rumination or at least attentional distraction from the task at hand (see also Baumann & Kuhl, 2002; Koole & Jostmann, 2004). In time-pressured tasks, such distraction clearly interferes with the eagerness of the active promotion focus leading to suboptimal performance. As the current research illustrates, action-oriented individuals are more flexible under stressful conditions. They are able to use the

eager response strategy of an active promotion focus because of the effective affect regulation, which prevents a lack of resources in post-error trials.

One might say that, at least in stressful situations, we found a specific kind of regulatory fit to exist between an action orientation and a promotion focus. In general, a fit between action orientation and regulatory focus could be of special importance when it comes to maintaining the active regulatory focus. Recent research suggests that eagerness to achieve a promotion goal is prolonged following success and diminished following failure, whereas the reverse holds for vigilance, a strategy for achieving prevention goals (see Förster et al., 2001; Idson, Liberman, & Higgins, 2000).

An action orientation may thus protect a promotion focus by down-regulating negative affect. Likewise, a state orientation may keep a prevention focus alive by eliciting rumination on events that are accompanied by negative affect. This fit between how one can and wants to regulate behavior may prove instrumental in maintaining a motivational focus. Although the existence of this particular type of regulatory fit is hypothetical at the moment, the importance of regulatory fit has been demonstrated in other domains. For example, fit between motivational focus and specific tasks has been shown to lead to higher efficiency of appraisals (Shah & Higgins, 2001), stronger motivation during goal pursuit (Higgins, 2000) and enjoyment of goal directed action (Freitas & Higgins, 2002; see also Keller & Bless, 2008). We tentatively suggest that not just certain tasks may fit a certain regulatory focus, but that the regulatory focus may fit certain individuals.

A procedural issue that needs to be discussed is the role of the error feedback that was provided to the participants. By providing error feedback, the question of whether the effects reflect a response to an error or to the error feedback is left open. We believe that it is the experience of making a mistake that activates negative affect and not the feedback. However, the feedback was necessary in the experimental task that was used to cause the experience of making mistakes. In

research using the classic flanker task, participants are generally aware of giving an incorrect response (see the error-related negativity research discussed below) since it is easy to ascertain a match or mismatch between the center symbol and flankers. The flanker task thus provides a rather simple visual discrimination task in comparison to the experimental task used in the current study. This experimental task was specifically designed to make the visual discrimination more difficult. Unfortunately, the task difficulty combined with the response window makes it much harder for a participant to detect the occurrence of an error. Our experimental task thus makes giving feedback on the responses necessary, and thereby leaves the question whether the obtained effects are caused by a response to the error or to the feedback unanswered.

We think the current behavioral effects, moderated by action orientation and motivational focus, are linked to the psychophysiological literature on action monitoring, which has explored how errors influence brain activity. Typically, a neural response to an error is found in the medio frontal cortex (anterior cingulate cortex or ACC), consisting of a sharp negative deflection in the event-related brain potential. This neural response reaches its peak approximately 100 ms following making an error and is termed error-related negativity (ERN or Ne; Falkenstein, Hohnsbein, Hoorman, & Blanke, 1990; Gehring, Goss, Coles, Meyer, & Donchin, 1993). The exact interpretation of what ERN reflects remains a matter of discussion (for a review and integration see Yeung, 2004) but it is clear that errors (as well as feedback indicating errors; Miltner, Braun, & Coles, 1997) evoke brain activity generated in the ACC that may be responsible for subsequent deteriorated performance.

As subject of an ongoing debate, ERN is interpreted cognitively, as well as affectively. One well researched cognitive interpretation entails that ERN signals conflict between two responses; the erroneous one and the error-correcting one (e.g., Yeung, Cohen, & Botvinick, 2004). However, affective interpretations have recently received much attention as well. To illustrate, Gehring and Knight (2000)

state that "[a] model consistent with our data posits that the activity reflected in the ERN represents an affective or motivational signal. The signal could serve an alerting function that mobilized affective systems rather than immediate corrective action…" (p. 519). This view is consistent with our perspective and recent work on ERN and ACC-activity (e.g., Hajcak & Foti, 2008; Luu et al., 2000). We do not posit that these interpretations are mutually exclusive; both mechanisms could operate jointly to steer our behavior in the right direction under conditions of stress or errors. Indeed, the ACC is thought to be an ideal location in which cognitive and affective information is integrated and responded to (Bush et al., 2000).

With regards to explaining the current results, we think the affective interpretation fits well with our data and theorizing. However, it should be noted that the current study does not provide direct evidence for the mediating role of affect and, therefore, alternative explanations cannot be excluded. For example, the conflict monitoring explanation for the ERN discussed above, has also been used to explain post-error slowing (Botvinick, Braver, Barch, Carter, & Cohen, 2001). Although this conflict monitoring account is well established, it does not incorporate affect regulation processes that play a pivotal role in the theory of action and state orientation (see e.g., Jostmann et al., 2005; Koole & Jostmann, 2004; Kuhl, 1994a). In a similar vein, affect also plays an important role in motivational theories such as regulatory focus theory (Higgins, 1997). Thus, although a conflict monitoring account seems capable of explaining post-error performance in general, the specific interaction effect between action orientation and regulatory focus obtained in the current study strongly suggests an affective account. For the time being, no plausible or more parsimonious explanation for the results of the current study seems available than one which accommodates for the affective consequences of making a mistake. In research on the ERN and post-error behavior Gehring and Knight (2000) explicitly acknowledge the possible role of affect in post-error performance by stating that "… the ERN could actually be a composite of several signals […] influencing affective

responses and […] compensatory motor behavior." (p. 519). Nonetheless, our theoretical affective explanation alone will not suffice and future research should specifically aim to demonstrate that the regulation of negative affect indeed plays this central role in predicting post-error behavior.

When it comes to integration of research domains, the current paradigm may prove valuable to link ERN research to work on action orientation and motivation. In studies on ERN, behavioral measures are not the main interest, although post-error slowing is sometimes reported (e.g., De Bruin, Mars, & Hulstijn, 2004; Hajcak, McDonald, & Simmons, 2003; Holroyd, Yeung, Coles, & Cohen, 2005). However, none of these studies reporting post-error slowing explicitly demonstrate a link between ERN-amplitude and behavioral effects. Studies on ERN usually focus on the amplitude of the ERN as a measure of the impact an error has on the individual. For example, the amplitude of the ERN increases when errors are more significant, for instance when accuracy is important (e.g., Hajcak, Moser, Yeung, & Simons, 2005). Also, ERN-amplitude following errors has been shown to be moderated by individual differences. For example, larger ERN amplitudes were found for students scoring high on negative mood states (or negative affect (NA), Hajcak et al., 2004; Luu et al., 2000), neuroticism (Luu et al., 2000) and for students scoring high on anxiety and worry scales (Hajcak et al., 2003) or obsessive-compulsiveness (Hajcak & Simons, 2002).

Although these moderators may encompass both components, some seem to involve heightened sensitivity to negative affect whereas others may be associated with difficulties in affect regulation. It is interesting to note that such factors related to affect regulation show conceptual overlap with the theory of action orientation. Specifically, ERN amplitude seems to be influenced by personality factors that show overlap with high levels of state orientation (e.g., see Kuhl, 1994a, for overlap and interrelations between anxiety, neuroticism, obsessive-compulsiveness and state orientation, see also Baumann & Kuhl, 2002). This overlap between factors

influencing ERN and state orientation provides further evidence for the idea that the concept of action orientation is highly useful in thinking about post-error processes, both in the form of brain activity and behavior. Action orientation may actually be more useful in studying task related post-error processes than the more broad personality factors used thus far, since it is assumed to be more closely tied to performance (see e.g., Diefendorff, Hall, Lord, & Strean, 2000). The specific paradigm we used may prove useful to further investigate the relation between individual differences, ERN and the behavioral consequences of making mistakes.

In the second experiment, the predicted three-way interaction failed to reach significance due to the fact that the non-significant pattern of means in the post-correct condition was similar to the significant (and predicted) pattern in the post-error condition. The meta-analysis suggests that we may, nevertheless, conclude that across the two experiments there was a significant three-way interaction and, because there was no significant interaction with experiment, the observed pattern did not differ between experiments. Theoretically, there is a somewhat speculative explanation for the weak pattern of means in the post-correct condition entailing, just like in the post-error condition, slightly better performance of action oriented participants in the promotion focus condition. Recently, a Correct-Response Negativity (CRN) effect was obtained, a negative deflection resembling ERN (Vidal, Hasbroucq, Grapperon, & Bonnet, 2000). Although the functionality of CRN is at this moment unknown, both ERN and CRN are thought to be involved in response monitoring (e.g., Hajcak et al., 2005). Furthermore, it seems that error and correct responses are processed more similarly under conditions of uncertainty, leading to similar patterns in ERN and CRN (Pailing & Segalowitz, 2005). Thus, the pattern we demonstrate to exist in post error task performance may be found in post correct performance as well when uncertainty about performance exists. Because in experiment 2 there was a trial-by-trial contingency of performance and pay-off, participants may have been acutely aware of the implications of making mistakes,

which may have induced a higher level of performance uncertainty than in experiment 1. This may have caused the weak CRN pattern in the post-correct condition in experiment 2. However, given the fact that little is known about the functionality of the CRN, this reasoning remains highly speculative.

Coda

The current study demonstrates that errors do not affect every person in the same manner. Dispositional differences in action orientation and situationally activated regulatory focus interact in predicting post-error performance. Though some may be destined to dwell on their mistakes and on that account suffer future performance deficits, others more readily move on and, given the right motivation, keep performing at the peak of their ability.

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Notes

1. Note that a state orientation disrupts task performance only during stressful or very demanding conditions. Performance does not suffer disruption under normal conditions wherein state-oriented individuals may even outperform action-oriented individuals (Koole, Kuhl, Jostmann, & Vohs, 2005; see also Diefendorff, Hall, Lord, & Strean, 2000).

2. In preliminary studies, we employed the classic flanker paradigm to investigate the effects of motivation and action orientation on performance following errors. We found the typical flanker effects, but in no study did we find effects on performance following errors. The flanker task is probably too easy to leave room for the influence of motivation and/or dispositional factors. We therefore devised a more difficult adaptation of the flanker paradigm, with a more complex decision criterion and longer inter-trial intervals.

3. Although the experimental paradigm employed a response window, we did analyze logarithmically transformed response latencies to check for effects using a repeated measures ANOVA with the results of the previous trial (within participants), regulatory focus and action orientation as factors. However, in both experiments, no main or interaction effects on these response latencies reached significance.

Table 1

Mean proportion of correct responses on the current trial following incorrect or correct responses on the previous trial as a function of regulatory focus and action orientation in Study 1 (with standard deviations in parentheses)

	Following incorrect responses		Following correct responses	
	State	Action	State	Action
Promotion	58 (20) $_{a}$	71 (18) $_{b}$	70 (15) $_{b}$	72 (14) $_{b}$
Prevention	63 (14) $_{a*}$	56 (16) $_{a}$	67 (11) $_{b*}$	65 (14) $_{b}$

Note. Means with different subscripts differ significantly from each other. The means marked with an asterisk differ on a marginally significant level ($p < .07$).

Table 2

Mean proportion of correct responses on the current trial following an incorrect response on the previous trial as a function of regulatory focus and action orientation in Study 2 (with standard deviations in parentheses)

	Following incorrect responses		Following correct responses	
	State	Action	State	Action
Promotion	61 (20)$_{a*}$	77 (14)$_{b}$	66 (17)$_{c*}$	78 (10)$_{b}$
Prevention	67 (15)$_{a}$	66 (13)$_{a}$	73 (16)$_{bc}$	73 (12)$_{b}$

Note. Means with different subscripts differ significantly from each other. The means marked with an asterisk differ on a marginally significant level ($p < .06$).

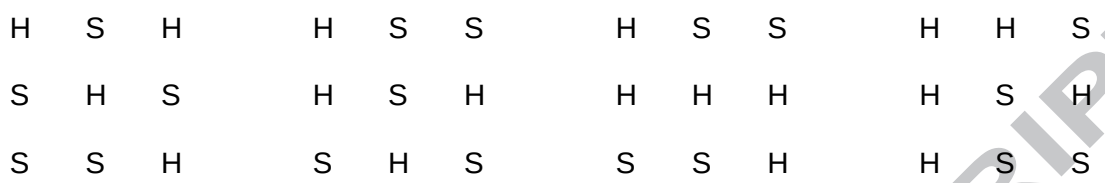

Figure 1. Examples of letter grids used in experiment 1 and 2.